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Biodiesel Fuel

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One of the alternative fuels beginning to attract increased attention is biodiesel fuel. In layman's terms, biodiesel is a fuel of non-petroleum origin yet it can be used in a diesel engine. The American Society of Testing and Materials (ASTM) refers to straight biodiesel fuel as B100 and a 20% biodiesel fuel / 80% diesel fuel blend as B20. However, some companies are finding it helpful to use biodiesel in mixtures as low as 1% to 2% because it has shown to restore the lubricity lost in the production of today's low sulfur highway diesel fuels. Further sulfur reductions are pending, from the current .05 wt.% (500 ppm), down to 15 ppm for low sulfur highway diesel fuel. Also, there are proposals for reducing the current high sulfur off road distillate from today's limit of .5 wt.% down to .05 wt.%. With these pending sulfur reductions, the lubricity benefits of biodiesel fuel may attract more attention.

In addition to increased lubricity, biodiesel fuel is reported to have several advantages. It contains no aromatics or sulfur. It has a high cetane number and its use reduces numerous emissions. It has completed the Tier 1 and Tier 2 Health Effects testing requirements of the Clean Air Act. The testing reported that emissions from biodiesel are nontoxic and pose little or no health hazard. The potential cancer causing particulate matter is reported to be 94% less than diesel fuel. It has a good energy balance because over 3 units of energy are produced for every unit of energy used to make it.

In preparing this article I learned the University of Missouri has been researching and experimenting with biodiesel for over 8 years. In addition, the National Biodiesel Board is located in Jefferson City, Missouri and they have an extensive website at www.biodiesel.org. Last month they reported students from the University of Wisconsin won the "Future Truck" competition with biodiesel. The testing began at the Ford Proving Ground in Yucca, Arizona and concluded at the California Motor Speedway in Fontana, California. And to think, if all those binge drinking reports this spring were true I was lead to believe the Madison students have been concentrating their work with that "other" alternative fuel.

The ASTM D 6751 Standard Specification for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels was issued this year. This was first issued as a proposed standard in 1999 and has been in development since 1994. The standard establishes specifications for the following properties.

- Flash point
- Water & sediment
- Kinematic viscosity
- Cloud Point
- Copper strip corrosion

Sulfated ash	Acid Number
Sulfur	Free glycerin
Cetane Number	Total glycerin

The biodiesel specifications are quite similar to diesel fuel specifications, except for slightly higher viscosity, ash and carbon residue. Three additional properties, not covered in the diesel fuel specifications, are in the new biodiesel standard. These include acid number, free glycerin and total glycerin. The new biodiesel standard contains the following cautionary statement, "blending biodiesel with a diesel fuel close to its upper limit could result in a biodiesel blend with viscosity above the limits contained in Specification D 975," for diesel fuel.

Biodiesel is registered with the EPA as a fuel and a fuel additive under Section 211(b) of the Clean Air Act. ASTM, in its discussion of biodiesel, reports "biodiesel is typically produced by a reaction of a vegetable oil or animal fat with an alcohol such as methanol or ethanol in the presence of a catalyst to yield mono-alkyl esters and glycerin. The finished biodiesel derives approximately 10% of its mass from the reacted alcohol. The alcohol used in the reaction may or may not come from renewable resources."

What are the drawbacks to biodiesel? Cost for one. A U.S. Department of Energy fact sheet reported the costs of B100 to be between $1.25 and $2.25 per gallon depending on purchase volume and delivery costs. When motor fuel taxes are added the cost of biodiesel, it is considerably higher than current diesel fuels. However, they reported a B20 blend would only be 13 to 22 cents more per gallon. The cold weather properties of biodiesel raise concern. With a cloud point reported as high as +30º F. cold weather storage and cold weather operations must be taken very seriously.

But despite these obstacles, work is moving forward because of biodiesel's many advantages along with Federal Government legislation and incentives. I also I learned of the EPAct program. This is a program designed to reduce petroleum consumption in Federal, State and public utility fleets. Using biodiesel fuel is an attractive alternative to gain what is termed EPAct credits. This allows the effected fleets using biodiesel fuel to fulfill up to 50% of their alternative fuel vehicle purchase requirements simply by using this alternative fuel. I will not go into the formula for calculating the benefit, but further information on the EPAct program is available at www.ott.doe.gov.

I spoke with Ron Hayes from the State of Missouri petroleum inspection program and he told me they currently have a small amount of biodiesel being marketed down there. The pump labeling is B20 biodiesel fuel. Because of biodiesel's cold weather properties he thought it is impractical to store it aboveground unless it was in heated storage. Despite the work being done on cold weather additives he thought a B10 biodiesel may prove more practical for winter months, but added there was some lubricity benefits to having a 1% - 2% blend in all diesel fuels nationwide.

Ron said their MDOT has been using B20 since March of 2001 with no real problems. They're able to get valuable EPAct credits to sell or trade.

Ron concluded by adding the biodiesel must be estrified to get the glycerin out. Ester is an organic compound formed by the reaction between acid and an alcohol, or phenol, with the elimination of water. Glycerin is an odorless, colorless, syrupy liquid prepared by the hydrolysis

of fats and oils; it is used as a solvent, skin lotion, food preservative and in the manufacture of explosives and alkyd resins.

The ASTM Significance of Properties provides the following discussion on glycerin.

> Free Glycerin – "high levels of free glycerin can cause injector deposits, as well as clogged fueling systems, and can result in the buildup of free glycerin in the bottom of storage and fueling systems."
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> Total Glycerin - "Low levels of total glycerin ensure that high conversion of the oil or fat into its mono-alkyl esters has taken place. High levels of mono-, di-, and triglycerides can cause injector deposits and may adversely affect cold weather operation and filter plugging."

Back in 1994 the Madison Bus Company provided us a biodiesel sample to test. It was a B20 blend with #1 diesel fuel. Our petroleum tests worked fine on the blend sample. But, we noticed a bit of a difference with the standard distillation test on the straight biodiesel sample. This was because diesel fuel is comprised of hundreds of compounds boiling at different temperatures having a wide distillation range from an initial of approximately 350° F. to the specification requirement of 540° - 640° F. at 90%. Biodiesel (B100), on the other hand, contains only a few different compounds which all boil at temperatures much similar to each other. These closer boiling temperatures produced a 603° F. initial, 644° F. at 90% and an end point of 672° F. The biodiesel standard just issued this year by ASTM specifies the vacuum distillation method, not the standard distillation we used.

I'd like to conclude by thanking Bob Jensen-Dept. of Revenue for his excellent help and with a quote from Hart's World Refining, Diesel Fuel News, "Biodiesel: On the Road to Fueling the Future," 2001. "But perhaps the most important boost to biodiesel's market value will come from the pressure to reduce sulfur levels in the nation's diesel fuel supply. As a pure fuel, biodiesel contains no sulfur. As a blendstock, even at levels of only 1 to 2 percent, biodiesel has been shown to restore the lubricity lost by the desulfurization of petroleum diesel. And because biodiesel is completely compatible with conventional petroleum diesel, it can be used to immediately and seamlesssly transform a diesel fleet into a cleaner burning, alternative fueled fleet without added investment.